REMARKS/ARGUMENTS

Claims 1 and 6-8 remain pending. Reconsideration is requested.

Ordinary motors can be put into practical use so long as they can generate desired torque. However, in the case of motors used for an electric power steering apparatus for vehicles as with the present invention, motors must also satisfy many other requirements directed to issues like clogging torque, torque ripple and inertia, all of which together have a direct influence on the synergistic result of "steering feel or touch" of the driver.

The "Background of the Invention" of the present specification discusses some relevant prior art references and addresses some of the various requirements for an appropriate electric motor for an electric power steering apparatus. For example, at page 2, line 23 to page 3, line 3, torque ripple or "fluctuations in the steering torque" are discussed, as follows:

> when the fluctuations in the steering torque are larger than those of a road reaction force due to certain factors, it is difficult for a vehicle driver to distinguish the fluctuations of the steering torque from the fluctuations of the road reaction force. Presence of the large fluctuations in the steering torque has a detrimental effect on steering smoothness upon turning the steering wheel to make a slight course change. Addressing this kind of detrimental effect provides improved steerability of the motor vehicle.

Then, at page 3, lines 15 -21, steering ripple or the fluctuations in the steering torque are discussed as emanating from clogging torque, as follows:

> In general, when armature windings are de-energized, cogging occurs between respective magnetic pulls of the stator and respective cores of the armature windings. Cogging is multiplied by a square of a reciprocal of gear reduction ratio of a worm gear mechanism, and the multiplied cogging is then transmitted as fluctuations to the steering wheel through the pinion shaft. The steering torque thus involves fluctuations.

And then, at page 4, lines 19-26, inertia is discussed, as follows:

> ... since an assist torque is produced responsive to a steering torque of the steering wheel, the rotor of the electric motor should have as small inertia as possible. Since, in this event, inertia of the rotor is transmitted to the steering wheel with a force equal to a value proportionate to the square of the reciprocal of the gear reduction ratio of the worm gear mechanism, lowering inertia of the rotor provides a comfortable steering touch or feel.

Thus, it is clear from the "Background of the Invention" that it is important to reduce fluctuations in the steering torque or torque ripple, reduce cogging torque which then helps to reduce torque ripple, and reduce rotor inertia to enhance responsiveness and, consequently, enhance a comfortable steering touch or feel.

Electric motor structure in accordance with claims 1 and 7 achieve these goals so that the smoothness of steering handling is enhanced. That is, the limitations of the structure of claims 1 and 7 work together synergistically to enhance "steering feel or touch" for the driver.

The Examiner rejected claims 1 and 6 under 35 USC §103(a) as being obvious on consideration of Coles, Nishiyama et al., and Sakashita et al. Also, the Examiner rejected claims 7 and 8 under 35 USC §103(a) as being obvious on consideration of Coles, Nishiyama et al., and Kazuo.

As discussed in the last Amendment dated April 30, 2003, for a motor having stator windings other than as required by claim 1 or claim 7 (such as a motor according to a hypothetical combination of Coles and Nishiyama), the net torque generated by the motor is very low. In order to generate a higher torque compatible with that required by electric power steering apparatus motors, an attempt could be made to increase the number of windings to a greater extent. Such attempt is, however, not practically achievable because of the considerable increase in cost and size of the resulting motor. Furthermore, due to the attracting and repelling of magnetic forces acting in a direction opposite to an intended rotating direction of the rotor, cogging torque occurs, which also renders the motor not suitable for use in an electric power steering apparatus.

The Examiner recognized that the previous rejection based on Coles and Nishiyama was untenable. The Examiner has then made the present rejections adding yet a third patent in each of them. In the present rejections, the Examiner finds the wiring method of Sakashita and the wiring pattern of Kazuo to be combined with particular features chosen from the Coles and Nishiyama patents to derive the motors of the pending claims. How does the Examiner know which features from these various references to use to obtain the motors of the claims? Sakashita and Kazuo show a motor having an outer rotor and an inner stator, which is a completely different type of motor than the claimed motor which requires an outer stator and an

inner rotor arrangement. The outer rotor and inner stator type motor of Sakashita and Kazuo cannot meet the requirements for an electric power steering apparatus motor, particularly the requirement for low inertia. An outer rotor has high inertia. How is it known that the outer rotor and inner stator features of Sakashita and Kazuo should not be combined with the number of poles and the number of slots of one or the other of Coles and Nishiyama? Clearly there is no motivation to take features from Sakashita and Kazuo to use in the motors of Coles and Nishiyama. Not only is there not motivation, but clearly hindsight is being used to select particular features from particular patents to reject the pending claims. The motors shown in Sakashita and Kazuo can be used as ordinary driving motors, but they cannot be used as electric power steering motors. In view of the totally opposite type of motor disclosed, Sakashita and Kazuo should be evaluated as non-relevant prior art references which cannot be reasonably considered with Coles and Nishiyama. The Examiner has not made a prima facia case of obviousness of these claims.

As indicated, Sakashita and Kazuo point away from a motor which has low rotor inertia by disclosing an outer rotor. Coles and Nishiyama point away from the synergistic effect of the limitations of the structure of claim 1 or claim 7. That is, in general, the number of poles of permanent magnets of a rotor of an electric motor and the number of slots (or poles of stator windings) of a stator are so related as to have a common deviser in view of the controllability of the motor. For instance, the motor shown in Coles has six poles and nine slots. For a set or integers 6 and 9 we can find an integer 3 as a common deviser. Similarly, the motor shown in Nishiyama has 8 poles and 12 slots, and we can find an integer 4 as a common divisor for a set of integers 8 and 12. In case of claims 1 and 7, the number of poles is 8 and the number of slots is 9. There is no common divisor found between the integers 8 and 9. By thus selecting the number of poles and slots, the least common multiple between the number of poles and the number of slots, which is direct proportional to the resonant frequency between the rotor and the stator, can be increased up to 72. Compare that with Coles having a least common multiple 18 where integers 6 and 9 and Nishiyama having a least common multiple 24 for integers 8 and 12. As the least common multiple becomes larger, cogging of the motor decreases. Since the least common multiple in the motor of claims 1 and 7 is three or four times the least common multiple of Nishiyama or Coles, the motors of claims 1 and 7 are much better in cogging performance than the motors of Coles and Nishiyama.

As will be understood from an understanding of the foregoing discussion, a successful balance of generated torque and steering feel or touch can only be achieved by reducing inertia, cogging torque and torque ripple which furthermore can only be achieved when all of the elements, such as 8 poles, 9 slots, winding pattern, and outer stator and inner rotor arrangement exist together, as required in claims 1 and 7 and the claims which depend from them. Applicant, in the claims, has invented motors for electric power steering apparatus which achieve a synergistic effect. See for example Fig. 10. The claims are non-obvious.

In view of the above, it is submitted that the application is in condition for allowance. Reconsideration is requested. Allowance of claims 1 and 6-8 at an early date is solicited.

Respectfully Submitted,

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Dated: December 17, 2003

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